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Preliminary test to characterize the soundscape of the *Plaza Mayor* in Madrid.

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ABSTRACT

This paper is a first step of a research about the analysis of the richness of the existing sounds in the *Plaza Mayor*, due to the old and traditional shops and bars under its porticoes together with the huge daily affluence of people.

In this paper we study the sound preferences of the salesmen and bar tenders at those traditional shops. These sound preferences include particular sounds, time of occurrence and date of specific annoying and pleasant sounds perceived at the square and the shops surrounding it. To carry out this study, several noise level measurements and socio-acoustic surveys were held. We will also try to correlate sound preferences and annoyance with noise levels of specific events existing at this particular square.

Keywords: Soundscape, socio-acoustic surveys, questionnaires, noise annoyance.

1. INTRODUCTION

The *Plaza Mayor* is an open public square in the city-centre of Madrid, Spain. The *Plaza Mayor* as we know it today is the work of the architect Juan de Villanueva who was entrusted with its reconstruction in 1790 after a spate of big fires. However, the origins of the *Plaza* go back to 1576. The square is rectangular and is surrounded by a 129 meters length by 24 meters wide portico. It is dominated by a bronze equestrian sculpture of Felipe II and it has nine entrance gates or entrance arches. It has been the scene of multitudinous public events such as markets, bullfights, religious processions, theatre plays, football games and, in the old times, even some public executions in the 16th century; that is why now it is a major tourist attraction, visited by thousands of tourists a year.

Figure 1 – *Plaza Mayor* in Madrid.

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2. APPROACH TO EVALUATE THE SOUNDSCAPE

Given that this square has the peculiarity of hosting shops under its porticoes, and the vast majority of these establishments are bars, restaurants and coffee bars that are open most of the day, we decided to take into account the opinion of the workers who have a great knowledge of what is happening in the *Plaza Mayor*. So, we designed a socio-acoustic questionnaire in order to know their opinion about the soundscape in the square.

First socio-acoustic surveys designed by the *Instrumentation and Applied Acoustic Research Group* (now forming the *CAEND*) were done more than twelve years ago by sociologists, engineers and statisticians. Those surveys have been updated and modified up to now. During these years, socio-acoustic surveys have been done in several areas, countries and languages, adapting the questionnaires to the environment [1-4]. Apart from that, different population sectors have been studied. During all these years the questionnaires have been modified, getting feedback of the results obtained in order to design new questions or change those confused ones. These changes have been done following international recommendations [5].

For this study in particular, we chose to redesign the questionnaire and make it shorter, as it would be distributed on paper to the workers in their working hours. The main idea was to reduce the answering time to 5 minutes approximately. In general terms, all the changes in the questionnaires have followed these guidelines [6]:

• Progressive difficulty in the questionnaire. Easier or clearer questions go at the beginning of the questionnaire and difficulty is increasing little by little. This way a bias in the answer is avoided: *"In community noise reaction surveys of a single noise source, the primary response question is usually placed before more extensive sets of questions about the same source to avoid the possibility of biasing respondents' answers by heightening their awareness of the effects of that noise source."* [7].

• Analyse previous results to determine the rejection percentage. This way every valid response percentage is set and main questions are placed before. Almost all the questions are closed questions in order to have homogeneous results. To determine subjective annoyance, verbal scale of continuous gradient (Likert) has been chosen, following international recommendations [6]. Several Ratings were measured by means of a verbal rating scale consisting of five categories: *Not at all, Slightly, Moderately, Very* and *Extremely*. Other numerical rating scale from 0-to-10 was also used to evaluate the soundscape and possible solutions to improve its perception.

• Generic writing of questions is made in a direct and easy way, but anyway, difficult questions must be put into context.

The goal of all these guidelines is to design a questionnaire attractive to the respondent, obtaining a high percentage of valid surveys, avoiding bias in the answers, achieving better qualitative and quantitative results.

The questionnaire is divided in 4 different sections and it is formed by 14 questions. Sections are listed as follows:

• Sociological data: This section is formed by 5 questions, requesting information about age, gender, length of service working at the *Plaza* and other sociological data.

• Noise annoyance: This section is formed by 1 question, requesting information about 18 noise sources (5 categories, verbal rating scale).

•Perception of the Soundscape: This section is formed by 4 questions, requesting information about the general perception of the soundscape, subjective evaluation of several adjectives (0-to-10 scale) to define the soundscape and dates and frequency of annoying noise events.

•Solutions to improve the Soundscape: This section is formed by 4 questions, requesting information about possible solutions to improve the soundscape at the *Plaza* (0-to-10 scale) and their knowledge and perception of a recent local legislation related to noise.

This research is to be developed in several stages, therefore this first stage will be used to create a final questionnaire improved by the initial results.

Additionally to the creation and dissemination of the socio-acoustic questionnaire, noise measurements have been carried out in order to correlate the subjective answers with the data objectively measured, as it is shown in the Figure 2.

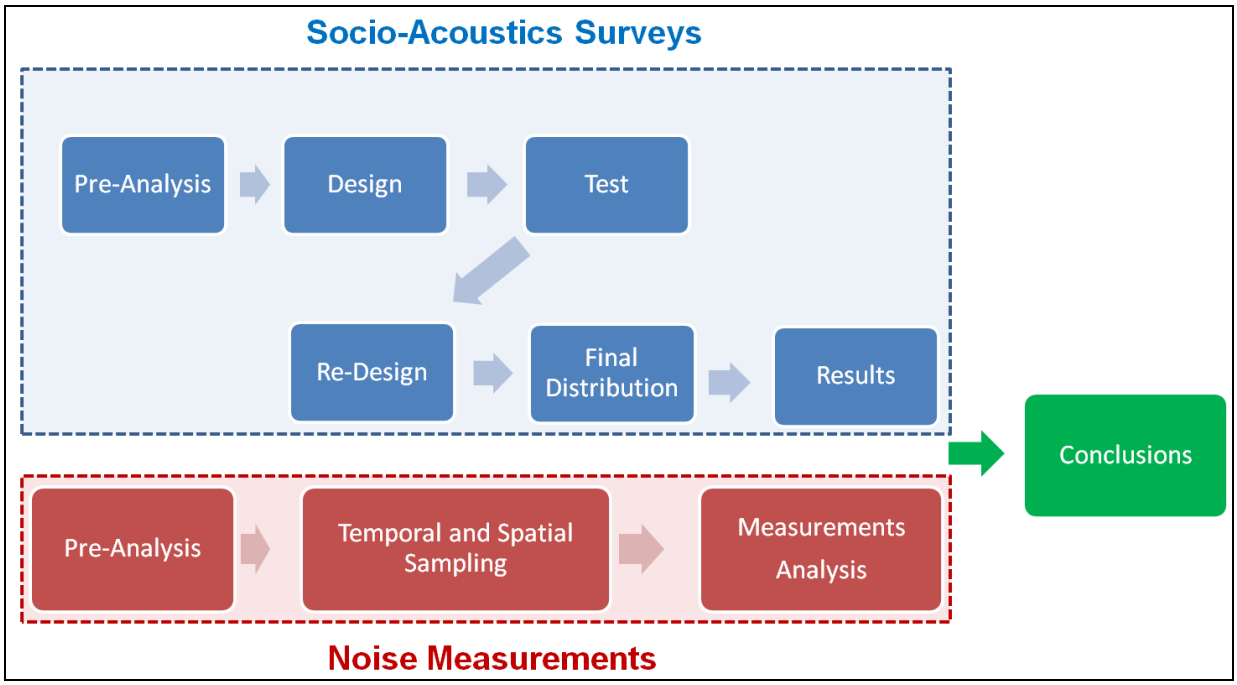

Figure 2 – Scheme of the approach chosen to evaluate the Soundscape of the *Plaza Mayor*.

3. FIRST TESTS RESULTS

At this first step, 21 valid questionnaires were collected, covering more than the 77% of the shops, bars and restaurants located under the porticoes of the *Plaza Mayor*. At first glance, it may seem that 21 questionnaires are insufficient to obtain reliable results. However, when analysing the length of service working at the *Plaza*, we confirmed that the workers, salesmen and bar tenders polled, have been working there for more than 14 years (mean value).

3.1 Sociological results

The analysis by gender is quite balanced: 52% of men and 47% of women. From the sociological analysis it can be highlighted that two clear groups are working at the Plaza:

- Young bar tenders from 20 to 30 years old (38%).
- People in charge of the restaurants and bars from 40 to 50 years old (29%).

3.2 Noise annoyance

Although the questionnaire was design as verbal questions in a five steps scale, the question about noise annoyance has been re-grouped as a three steps scale in order to show clearer results, following other researches about scales for noise annoyance questions [8]. The results are shown in Figure 3.

3.3 Perception of the Soundscape

Considering the general soundscape of the *Plaza* (before a brief definition of "Soundscape"), only the 25% of the people answered they felt it was "not at all" or "slightly" annoying.

Then, based on other international researches [9, 10], several adjectives to describe the soundscape were asked in a 0-to-10 numerical scale. The adjectives evaluated were: Relaxing, Noisy, Unpleasant, Annoying, Varied, Pleasant, Characteristic, Folk, Exciting, Unique in Madrid, Unique in Spain and Unique in the World. No relevant results were found but the majority part of the polled people did not found the soundscape as relaxing (3.6 mean value) while they perceived it as noisy (6.7 mean value). More than the 94% think that the soundscape at the *Plaza* is more annoying during the summer and in the evening and the night-time. 63% of them think the *Plaza Mayor* is one of the noisiest places in Madrid city-centre.

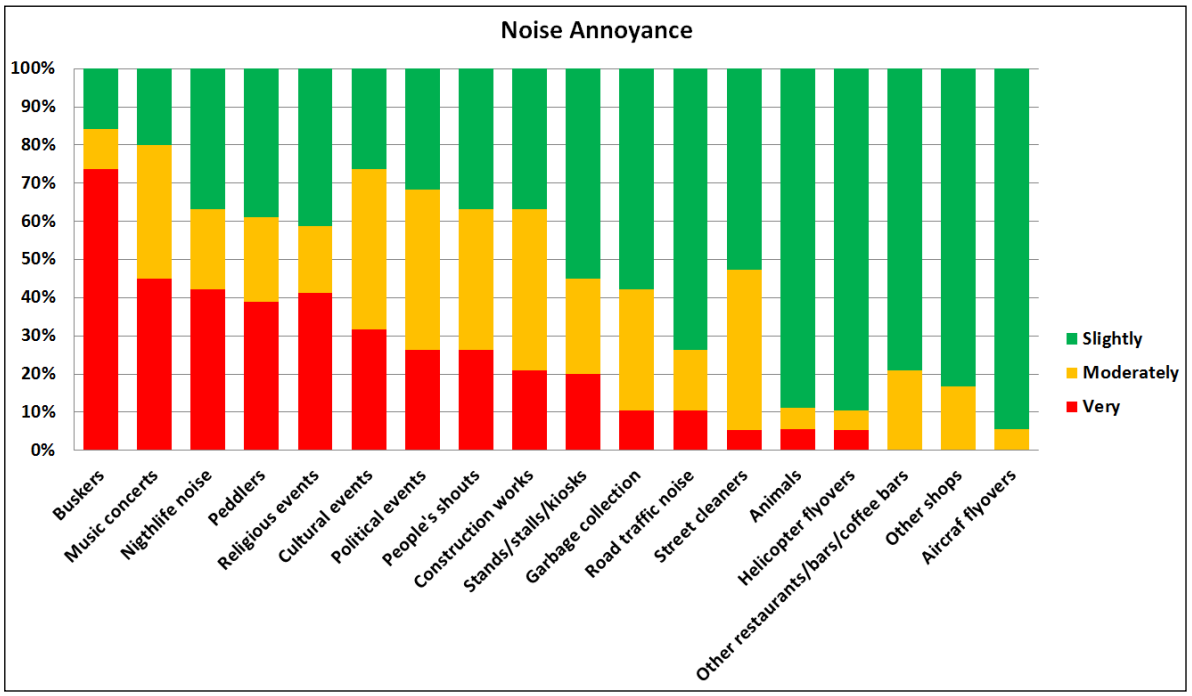

Figure 3 –Annoyance caused by different noise sources at the *Plaza Mayor*.

3.4 Solutions to improve the Soundscape

Several solutions to improve the soundscape of the *Plaza Mayor* were evaluated with a 0-to-10 numerical scale: *Legislating peddlers; Prohibiting peddlers; Legislating buskers; Prohibiting buskers; Reducing stands/stalls; Prohibiting stands/stalls; Reducing concerts; Prohibiting concerts; Reducing events; Prohibiting events; Planting trees/vegetation; Building fountains and waterfalls*.

In general terms, the people surveyed are against the completely bans (4.2 mean value) but they are in favour of legislating the buskers (7.0 mean value) and reducing the number of concerts in the *Plaza*.

As three months before carrying out the first test survey, a new local legislation related to environmental noise in Madrid was approved [11], we decided to ask the workers about it. This legislation dealt with buskers, among other environmental noise issues. The results showed that only the 7% knew about the new legislation related to noise. After informing them about the new legislation, the 93% think that noise has not changed at all since the legislation came into effect at the *Plaza Mayor.*

3.5 Noise measurements results

Several measurements with a B&K 2250 were done in order to evaluate typical events existing at the *Plaza*. A summary of the measurements of these noise events, including regional festival and religious processions, is shown in Table1. The richness of the soundscape of this characteristic *Plaza* is also shown in Figure 4.

4. FIRST CONCLUSIONS

This first approach to evaluate the soundscape in the *Plaza Mayor* seems to be valid. Although a small amount of reliable questionnaires have been collected, they are very representative of the population surveyed (more than 77%). The results of the noise annoyance are very coherent with the proposed solutions to improve the Soundscape (see 3.4 subsection), identifying the buskers and the concerts as the most annoying events at the *Plaza*.

Also the noise measurements reveal the buskers as the noise event with higher LAeq, more precisely those playing the accordion and the tambourine.

In a further step, this research will be used to poll the neighbours in the surroundings of the *Plaza* and comparing those results with new sets of noise measurements.

Table 1 – Several noise events measured at the *Plaza Mayor.*

Event	Distance to SLM (meters)	Duration (minutes)	LA eq (dBA)	LC eq (dBC)	Main description
Horse parade	15	4	71.5	73.1	Noise of the horses' hooves on the paving stone has a great high frequency component. Horses' neighs. Riders' shouts and orders. Spontaneous applauses and shouts.
Parade with the traditional costume at Madrid's San Isidro	15	5	69.1	72.3	Noise of the parade. Noise of the steps (soles and shoes) on the paving stone. Spontaneous applauses and shouts.
Music Band (drums and bass instruments)	15	8	73.6	84.7	Noise of a band, including drums rolls and several bass instruments as trumpets, flugelhorns, trombones and *piccolo* trumpets.
Religious procession	15	4	70.2	76.9	The religious fraternities and brotherhoods hold statues of saints on floats. This procession makes a very recognizable noise keeping the steps synchronized with the drums rolls. Spontaneous applauses and shouts mixed with an atmosphere of mourning and respect.
Heel stamping and Spanish guitars (*flamenco*)	6	5	71.2	73.8	Impulsive noise. Heel stamping noise over a wooden deck is quite characteristic and identifiable. Spanish guitar at open spaces is usually played without an amplifier. One guitar plays the base rhythm while the other one plays the plucking.
Accordion and tambourine (buskers)	4	10	77.9	79.8	Characteristic sound of the accordion (bellows and keys) with a very identifiable timbre. Characteristic sound of the metal jingles of a tambourine without a drum head by stroking or shaking the jingles. Both instruments have high mid-high frequency content. Notes (pure tones) and arpeggio are noticeable.
Street performance	6	5	70.6	71.7	Busking and imitating the noise of the goat's hooves on the paving stone.

Figure 4 –Several pictures showing the richness of the soundscape in the *Plaza Mayor*.

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